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compound may be correlated with the ability of this element to act as it does in Grignard's reaction, as has been suggested by Willstätter.[11] The relatively greater toxicity of potassium over sodium, as in Loeb's experiments with Fundulus, may be ascribed to selective absorption or membrane permeability. The connection between these pairs of elements in magmas and minerals may be ascribed to differences in solubility.

Each one of these or other such explanations, taken individually and separately, may be rational and valid; but taken collectively, especially in view of the congruity of the four elements in the mineral and organic kingdoms, they make it appear possible and indeed reasonable to ascribe the correspondence to some fundamental chemical relation between the elements involved, of which such proximate causal nexuses as have been suggested are the consequences. No hypothesis can be offered as to what may be the nature of this relation; only the mere possibility of its existence, based on the correspondences set forth in this and the preceding paper, can be suggested.

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[1] H. S. Washington, these PROCEEDINGS, **1**, 574 (1915).

[2] Cf. Reichert and Brown, *Carnegie Inst. Publ.*, No. 116, 24 (1909).

[3] O. Hamarsten (Transl. by Mandel), *Textbook of Physiological Chemistry*, p. 564 (1900).

[4] Cf. S. B. Schryver, *Science Progress*, 3, 440 (1909).

[5] Reichert and Brown, op. cit., 1; Schryver, op. cit., 444.

[6] E. Strasburger et al. (transl. by Porter), *Text-book of Botany*, 173 (1898).

[7] Cf. J. Loeb these PROCEEDINGS, **1**, 473 (1915); **2**, 511 (1916).

[8] It is suggested that the lesser toxicity of the ferric salts may be ascribed to their ready hydrolysis and the consequent formation of very difficultly soluble basic compounds.

[9] Op. cit., 2.

[10] Copper, likewise with two valencies, exists in the blood of certain lower animals, as mollusca, limulus, helix and sepia.

[11] The dependence of plant life on magnesium and of animal life on iron, and the difference in their functions, is expressed by Willstätter as follows: "There are fundamentally two kinds of life, which develop alongside of each other; the anabolic life with magnesium and the katabolic life (of animals) with iron, that is a reducing and an oxidizing life." *See Liebig's Ann. Chem.*, **250**, 65 (1906).

THE OAKS OF AMERICA

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For a number of years I have been engaged in a study of the oaks of tropical America. These have not been treated comparatively for a generation, with the result that the extensive collections made within that time have gone into herbaria largely unnamed or wrongly named.

My feeling has been that the only way to unravel the difficulties was to begin with the study of types of the earlier species, passing to those of later date and deferring examination of unauthentic collections until the end. Though it was not possible to carry this plan out in all detail, it has been my privilege to see most of the types of tropical American species, and to photograph in natural size representative parts of them whenever found, so that whatever errors may have slipped in, they scarcely include a misapprehension as to what is meant by the earlier used names except for one or two of Née's species of which no identifiable material is known to remain.

It was not until this study of the forms that occur to the south of us had been essentially finished, that it seemed best to include in my treatment those of the United States. These have been so long and so repeatedly studied and for the most part figured that little would seem to have been left undone with them. Yet within the year Professor Sargent has pointed out a serious misapprehension as to the proper Latin names of the rock chestnut oak and the cow oak, and has made it very questionable whether what we know as red oak in the northern States is what Linnaeus called *Quercus rubra*. As I finish my manuscript, in which for completeness the northern oaks are included summarily, I have a feeling that more uncertainty still attends several of these polymorphic species than perhaps any one which occurs in the tropics; and unfortunately this uncertainty for the most part cannot be removed by reference to types, which do not exist for the most puzzling of these northern species.

A careful analysis of the characters presented by wood, inflorescence and flowers leads me to believe that the Fagaceae are far from being the primitive plants that they are commonly taken for, and I am disposed to conclude that their affinities are with such seemingly advanced and certainly specialized but still really simple orders as the Ranunculales and Rosales, from the type of which they have receded.

On this continent, the oaks (excluding *Pasania* as a distinctly separable genus) seem to fall into three subgenera or main groups instead of two as usually understood, Leucobalanus, the white oaks, typical of *Quercus;* Erythrobalanus, the red or black oaks; and Protobalanus, a more ancient type as I conceive it, comprising the protean intermediate assemblage clustering about *Q. chrysolepis*.

Summarized, my study of American materials contained in the principal herbaria of the world leads to the recognition of 354 species, of which 158, or very nearly one-half, are described as new in the manuscript which I am now prepared to submit to the Academy for publication, in which 183, or slightly over one-half of the whole, are figured for the first time. As in our immediate flora, white and red oaks occur in approximately equal numbers for the American flora as a whole: 170 species of the former, and 179 of the latter, only 4 species of Protobalanus being known.

In variety as well as in actual number of species, the countries to the south of us are much richer in oaks than the Atlantic United States—a result to be expected from the more rugged configuration and greater meteorologic differences in those countries. The principal facts of the distribution of American oaks by countries are indicated in the following table. A very few species occur in more than one country, and therefore are counted for both.

COUNTRY	LEUCOBALANUS	PROTOBALANUS	ERYTHROBALANUS	TOTAL
United States	43	2	26	71
Mexico	121	2	125	248
Central America	20	0	35	55
South America	0	0	4	4
Antilles	1	0	0	1
Pacific Islands	0	1	0	1

A glance at this table shows that, rich as the United States are in oaks, they are nearly equaled by the small Central American countries and far surpassed by Mexico. In the West Indies only a single species of white oak, doubtfully distinct from the live oak of our Gulf States, occurs, and this unquestionably derived from our mainland. In South America there are only four closely related species, of the red oak group, and these are clearly allied with some of the Costa Rican species.

The genus *Quercus* is conceded to have existed in Cretaceous time though many Cretaceous and Tertiary fossils formerly referred to this genus are now placed in *Dryophyllum*, which is taken for the ancestral stock of the Fagaceae rather than of *Quercus* alone. Paleobotanists now admit 150 species of American fossil oaks pretty evenly distributed through the Cretaceous and the Eocene and Miocene divisions of the Tertiary. Few Pliocene fossils are known for North America; but in South America where a few others have been made known for the Argentine, 4 species have been described from Pliocene deposits of equatorial Brazil. It is noteworthy that the few existing South American oaks are confined to the Andes of Colombia.

So far as I know, none of the earlier species survived from one to another of the periods of geologic time except for *Q. furcinervis americana* (perhaps two distinct species) in Eocene and Miocene deposits, and that what has been taken for the existing *Q. chrysolepis*—the type of the subgenus Protobalanus—occurred in the Miocene; but this identification might well be questioned by a critic. A proper understanding of the affinities of existing groups of species undoubtedly calls for a just appreciation of their connection with these ancestral forms. This I do not profess to have formed. I find the occurrence of a few aberrants—among them the South American species—in the subgenus Erythrobalanus puzzling, but can see no satisfactory evidence that red- or black-oaks are recognizable in any of the older fossils; and the group is certainly exclusively American today. Notwithstanding this, a resemblance is observable between the white oaks of Europe and those of western rather than eastern America, that proves puzzling.

On the whole, I am unable to trace any existing groups to those of Tertiary time. Pleistocene species, of which 18 are recognized for the United States, as is to be expected are scarcely different from those of today, though they are sometimes given distinctive names. In the early Pliocene should be sought definitely recognizable ancestral forms of these and their living descendants.

Considering the multitudinous—and in their extremes very diverse—types of such an existing assemblage as that of the Rocky Mountains, in which Engelmann and other excellent botanists have been unable to see more than a single polymorphic species, and the comparable range—to which the keen von Ettingshausen refers the manifold European oak types of today—in the fossil *Q. Palaeo-Ilex*, I am unable to see that all of the existing American oaks may not have descended from a single synthetic type of this kind, such as the Miocene species that has been held to be identical with the existing intermediate oak *Q. chrysolepis*. Out of this type, rightly or wrongly, I have built the present divergent branches of white and red oaks as I understand their affinities, believing that the European and American white oaks have no direct connection and that on each continent the manifold and often parallel forms of today have been independently derived from distinct late Tertiary types not closely related to one another in descent.